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Challenges of maintaining and diffusing grassroots innovations in alternative food networks: A systems thinking approach

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ABSTRACT

Sustainability transitions of food systems are at the core of several of the United Nations' Sustainable Development Goals (SDGs). In many regions, grassroots initiatives (i.e., community-led bottom-up initiatives) have emerged to experiment with alternative food networks and change the dominant food regimes. While grassroots initiatives can play a crucial role in sustainability transitions, it is known that actors usually face challenges related to (1) building and maintaining an initiative, and (2) diffusing it to the mainstream. However, the systemic mechanisms underlying these two types of challenges in food systems are still underspecified. Building on previous empirical research, the paper uses systems thinking (qualitative causal loop diagrams) to detail (1) the systemic mechanisms underlying the emergence and maintenance of an alternative food network; and (2) the feedback loops related to organizational and logistics issues that pose limits to scaling. It explains the paradox of diffusion in alternative food networks and concludes that diffusion of alternative food networks to mainstream may be achieved through replication and translation strategies, rather than scaling-up.

1. Introduction

Food systems—networks of actors and activities involved in agricultural production, processing, packaging, storage, transport, distribution, and waste disposal (Brouwer et al., 2020)—contribute around one-quarter of global anthropogenic greenhouse gas emissions (European Commission, 2020). Hence, transitions toward alternative, more sustainable food systems are urgently needed to maintain or enhance natural capital (e.g., land, soil, water) and leave the ecosystem intact (European Commission, 2020; United Nations, 2015). In many regions, *grassroots initiatives,* that is, networks of activists and organizations aiming to create bottom-up solutions for sustainable development (Seyfang and Smith, 2007), have emerged to experiment with alternative food networks. Such alternative food networks typically focus on organic production and local distribution (Gaitán-Cremaschi et al., 2019; Little et al., 2010; Sonnino and Marsden, 2006; Therond et al., 2017; Vermeulen et al., 2012). In contrast to *market-based niche innovations* that adhere to market rules, *grassroots innovations* function in the spirit of a social economy: As social innovations, they strive to meet the demands and interests of the communities involved (Seyfang and Smith, 2007). For example, grassroots innovations in food systems may increase the availability and accessibility of healthy, regional food and strengthen local economies (Gernert et al., 2018).

While there has been a long-standing tradition to study how *market-based innovations* can prosper and enter mainstream markets, the underlying processes of how *grassroots innovations* emerge and contribute to sustainability transitions are less well-understood (Seyfang and Smith, 2007; Seyfang and Longhurst, 2016). It is known that there are general challenges related to (1) building and maintaining a grassroots initiative, and (2) diffusing grassroots innovations to 'mainstream' (Seyfang and Smith, 2007). In the context of alternative food networks, earlier research has specified the related problems of (1) maintenance due to lacking organizational and legal structures (Little et al., 2010) as well as over-reliance on key stakeholders (Kirwan et al., 2013) in combination with too many 'free riders' (Tavella and Papadopoulos, 2017). Problems of (2) diffusion to the mainstream were found to be related to opposition from the dominant food industry (Laforge et al., 2017) but also to scaling issues: When they grow in size, distributors tend to source less from local and regional food and vegetable providers (Clark and Inwood, 2016) and they tend to exert more pressure (e.g., regarding prices) on farmers and producers than in smaller alternative food networks, where power is more balanced (Gaitán-Cremaschi et al., 2019;

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Lamine et al., 2019).

However, while the existing studies have provided important insights on how diverse variables may *individually* affect the functioning of grassroots innovations in alternative food networks (for a review, see Gernert et al., 2018), less attention has been paid to *interactions* of these variables. Most importantly, consumers' motives (e.g., Connelly and Beckie, 2016; Little et al., 2010) have largely been treated in isolation from farmers' production and logistics challenges (Jaklin et al., 2015; Fikar and Leithner, in press). Hence, a truly systemic perspective on problems related to the maintenance and diffusion of alternative food networks is missing as yet.

In the present paper, we aim to close this gap and answer the following interrelated questions: *What are the inherent systemic interactions amongst variables related to* (1) the *emergence and maintenance of an alternative food network* and *to (2) the diffusion of alternative food networks to the mainstream*? To answer these questions, we use a systems thinking approach. Systems thinking studies the sum rather than the parts of a system—such as an alternative food network—by focusing on its overall purpose and the interconnected elements (Meadows, 2008). In contrast to a systematic literature review, like the one provided in Gernert et al. (2018), that aims to give a comprehensive, systematic overview of related literature, a systems thinking approach seeks to identify the interaction dynamics, feedback loops, and information flows between variables within the studied systems (Meadows, 2008). This is particularly of importance in alternative food networks as these systems are often characterized by democratic and participative decision-making processes (Tavella and Papadopoulos, 2017).

In this paper, we develop causal loop diagrams (CLDs) to provide a systems thinking perspective for grassroots innovations in the food industry. CLDs are visual tools to facilitate systems thinking and, consequently, enable policy and decision-makers to better understand feedback loops and causal relationships (Morecroft, 2015) that may exist in alternative food networks. While quantification is often challenging as it requires various strong assumptions on model relationships, particularly if multiple soft variables are present (Coyle, 2000), qualitative CLDs facilitate a profound understanding of the dynamics and feedback loops of the underlying system (Lane, 2008). As a concrete application case, we focus our analysis on one prototypical example of grassroots innovations, namely *food cooperatives* (Kirwan et al., 2013; Laforge et al., 2017; Little et al., 2010; Pellicer-Sifres et al., 2017) where groups of consumers organize collective purchases from local farmers, thereby creating short, regional food supply chains.

Our main contribution is the identification of typical systemic processes and feedback loops related to building, maintaining, and scaling alternative food networks, visualized by CLDs. The resulting CLDs show that a certain level of structure is needed to fulfill the various needs of consumers; at the same time, too much standardization destroys many of the benefits of an alternative food network such as trust and personalization. Moreover, the CLDs reveal challenges related to farmers' logistics capacities which further limit the growth of a food cooperative. Overall, this work responds to recent calls in the literature to study pathways for generating food system change (Brouwer et al., 2020) and contributes to a better understanding of micro-level processes underlying sustainability transitions in socio-technical regimes (Geels, 2020).

The remainder of the paper is organized as follows. Section 2 provides the theoretical background on sustainable alternatives to conventional food systems and the role of grassroots innovations for sustainability transitions. Section 3 describes the general methodological approach (qualitative CLDs) and the modeling procedure based on an iterative literature review. In Section 4, the developed CLDs are presented. Derived implications are discussed in Section 5 and concluding remarks are given in Section 6.

2. Theoretical background

Sustainability transitions of food systems are at the core of several of the United Nations' Sustainable Development Goals (SDGs; especially, SDG2, SDG12; United Nations, 2015) and also of the EU Taxonomy for sustainable activities (European Commission, 2020). Sustainability transitions are "long-term, multi-dimensional, and fundamental transformation processes through which established socio-technical systems shift to more sustainable modes of production and consumption" (Markard et al., 2012, p. 956). The following sub-sections introduce key elements of alternative, sustainable food systems and provide the theoretical basis of the underlying processes of sustainability transitions.

2.1. Sustainable alternatives to conventional food systems

Food systems include various actors (e.g., farmers, consumers, institutional networks) and a wide range of activities (e.g., production, preparation, marketing, retail; Brouwer et al., 2020; Ruben et al., 2018). Because the ecological goals for sustainable agriculture are comparatively well-understood (e.g., European Commission, 2020), the present paper focuses on those elements of the food supply chain related to retail and distribution structures.

Food supply chains can range from small cooperatives to large chain distribution networks. At present, in many parts of the world, *conventional* food systems are dominated by large-scale farming (Rivera et al., 2020). Conventional supply chains adhere to principles of the "corporate food regime" (McMichael, 2009, p. 147); that is, an industrial approach to food production and distribution, "primarily geared to producing large amounts of standardized foods" (Gaitán-Cremaschi et al., 2019, p. 2). Although small farms account for 86,3% of all farms in the EU and 68,1% of the labor force directly working on farms (Eurostat, 2018), they are exposed to strong competition by those industrialized farms and ever-increasing pressure to improve efficiency and drive down cost (Vettas, 2007). Despite their relative neglect in policies and their low bargaining power, however, small farms play an extremely important role in food provision, the protection of landscapes and the environment, resilience of local communities as well as rural economic viability (Rivera et al., 2020).

To strengthen the role of small farms and counteract problems of conventional food systems, *alternative* food networks have emerged in many areas (Gaitán-Cremaschi et al., 2019; Little et al., 2010; Marsden and Sonnino, 2012; Sonnino and Marsden, 2006; Therond et al., 2017; Vermeulen et al., 2012). Although no precise definitions exist, the term alternative food networks usually refers to initiatives that aim to directly link producers and consumers, predominately at the *local* scale (Lamine et al., 2019; Sonnino and Marsden, 2006; Therond et al., 2017). Typical examples of alternative food networks include farmers' markets, food box schemes, and food cooperatives (Kirwan et al., 2013).

Due to their local character, alternative food networks are usually much smaller in scale than conventional ones. Retailers in conventional food systems tend to work with large suppliers (i.e., intensive corporate farming) and move large volumes of product, whereas alternative food networks tend to collaborate with small farmers to source regional food (Clark and Inwood, 2016). While in large (conventional) food systems, farmers are exposed to severe power asymmetries, in alternative food networks, power is more balanced amongst actors (Gaitán-Cremaschi et al., 2019; Therond et al., 2017).

Because of their larger scale, conventional food systems are normally highly standardized (Lamine et al., 2019). Large retailers often have specific distribution systems and cooperate with farmers through contracts; at the other end of the spectrum, small-scale cooperative retailers interact based on social relationships (Clark and Inwood, 2016). Commitment between participants of the conventional food system is low and largely based on economic benefits; in contrast, alternative food networks exhibit high levels of trust and commitment, and democratic value chains, which are embedded in the local communities (Gaitán-Cremaschi et al., 2019).

In summary, value chains of alternative food networks oppose conventional food systems' principles of distance and standardization

(Lamine et al., 2019). They are more democratic, territorially embedded, and self-organized (Gaitán-Cremaschi et al., 2019). By supporting small farmers, they contribute to biodiversity and foster local communities (Therond et al., 2017). Taken together, this can have positive effects on both environmental and social sustainability (Lamine et al., 2019; Therond et al., 2017; Vermeulen et al., 2012).

Importantly, in the food industry, conventional and alternative food systems are blurry and often permeable in the sense that actors and activities overlap (Gaitán-Cremaschi et al., 2019; Sonnino and Madsen, 2006). While there is competition between the two (Sonnino and Madsen, 2006), actors in the conventional food system are often sympathetic to innovations in alternative food networks and many hybrid forms exist (Gaitán-Cremaschi et al., 2019).

2.2. Grassroots innovations in sustainability transitions

2.2.1. The role of grassroots innovations for transitions

Sustainability transitions toward more sustainable food systems imply changes in multiple dimensions (e.g., technological, political, socio-cultural; Köhler et al., 2019; Markard et al., 2012) and involve multiple actors such as farmers, retailers, consumers, and policy-makers (El Bilali, 2019a; Gaitán-Cremaschi et al., 2019).

One of the most prominent models to theorize about sustainability transitions is the Multi-Level Perspective (MLP, Geels and Schot, 2007; see also Geels, 2005, 2011; Rip and Kemp, 1998). According to the MLP, sustainability transition results from an interplay of system dynamics at three levels (Geels, 2005, 2011): the *socio-technological regime*, the *landscape,* and the *niche* level. The regime is the incumbent socio-technical system (e.g., the conventional food system), including the network of actors, their tools, and their formal and informal rules. The landscape is the exogenous environment in which the regime operates (e.g., food culture, agricultural regulations, or climate). The niches are arenas of innovation, which do not adhere to the rules of the socio-technical regime but often oppose them. The above-described alternative food networks can be seen as niches in the food industry (El Bilali, 2019b; Gaitàn-Cremaschi et al., 2019). The MLP theorizes on several general system dynamics across these three levels: niche innovations can build up internal momentum, changes at the landscape level can put pressure on the extant regime, and the destabilization of the regime can create windows of opportunity for niche innovations.

Although sustainability transitions are not always bottom-up processes (Geels and Schot, 2007), the MLP literature highlights the relevance of *grassroots innovations* (as opposed to market-driven innovations), where networks of activists and organizations develop bottom-up solutions for sustainable development (Hossain, 2016; Ingram et al., 2015; Leach et al., 2012; Seyfang and Smith, 2007). Grassroots innovations emerge from both, an unmet need and an "ideological commitment to alternative ways of doing things" (Seyfang and Smith, 2007, p. 592). Beyond concerns of food quality, participants of grassroots initiatives are usually concerned with community, social justice, and environmental sustainability (Ingram et al., 2015).

Typical grassroots innovations in alternative food networks, like food cooperatives or food box schemes, do not only aim to ensure access to healthy and affordable food, but they strive to achieve social benefits for the community, such as social inclusion and cohesion (Kirwan et al., 2013; Pellicer-Sifres et al., 2017). In consequence, participants are often highly motivated to create structures that serve their needs better and are more aligned with their values (Seyfang and Smith, 2007), and to take back some control over their own food supply (Little et al., 2010; Pellicer-Sifres et al., 2017). By uniting their forces, grassroots actors can increase their power to change the 'rules of the game' (Seyfang and Smith, 2007) and show that 'we can do it better' (Little et al., 2010).

2.2.2. Challenges of grassroots innovations

In their seminal article on grassroots initiatives in sustainability transitions, Seyfang and Smith (2007) argued that there are usually two sets of challenges. The first is related to building and maintaining the grassroots initiative. In the beginning, a grassroots innovation requires a particular combination of skills, key actors, and infrastructure. Then, after start-up, the challenge is to survive and maintain the structures over time. The second set of challenges is related to their diffusion to mainstream practices, which comes with an inherent key paradox: The 'different rules' (as opposed to the incumbent regime) can have certain strengths at a small scale, which can turn into barriers at larger scales.

Some of Seyfang and Smith's (2007) general assumptions were observed in later studies in the food industry: For example, regarding the challenges of building and maintaining grassroots initiatives, it was found that alternative food networks are often based on voluntary, unpaid activities of their key stakeholders (Kirwan et al., 2013). They require an initial group of dedicated actors (e.g., a set of dedicated buyers and one or more farmers) and storage room such as an empty garage (Crivits and Paredis, 2013). Thereby, alternative food networks can struggle to develop functional organizational and legal structures (Little et al., 2010).

Concerning the challenges of diffusion to the mainstream, alternative food networks can be confronted with various forms of opposition from the dominant food regime (Laforge et al., 2017). Moreover, regarding the 'paradox of diffusion' (Seyfang and Smith, 2007), findings from the food industry suggest a relationship between scale and 'localization': Very small distribution networks tend to source local and regional food and vegetables, while large distributors usually do not source regional products (Clark and Inwood, 2016). It is exactly the smaller scale of alternative food networks that allows them to operate based on trust (instead of formal contracts) and with a lower amount of standardization than conventional food systems, and why power between actors (e.g., farmers, consumers) is more balanced (Clark and Inwood, 2016; Gaitán-Cremaschi et al., 2019; Lamine et al., 2019).

Despite the numerous important insights from these studies, there are two limitations. The first limitation is the surprising lack of a systemic perspective (Morecroft, 2015) that considers non-linear, dynamic interactions among systems' actors (e.g., farmers, consumers). Both, the MLP and the grassroots innovation literatures are based on inherently systemic assumptions: Sustainability transitions emerge through feedback processes of mutual reinforcement or inhibition (Geels and Schot, 2007). Nevertheless, these systemic mechanisms are hardly considered in sustainability transitions research. As a second limitation, related work mostly focuses on a *strategic* farmer or consumer perspective, while *operational* challenges are less investigated. Such operational factors, however, are frequently listed as a major obstacle to the successful implementation of alternative food networks (Paciarotti and Torregiani, 2021) and, consequently, require special attention. In this paper, we address both these gaps by taking a systems thinking perspective on the operational challenges related to the maintenance of grassroots innovations in the food industry and their diffusion to the mainstream.

3. Method

The following sub-sections provide a rationale for the application of qualitative causal loop diagrams (CLDs) and describe our iterative modeling procedure for the application case of food cooperatives as typical grassroots initiatives in the food industry.

3.1. Why causal loop diagrams (CLDs)?

CLDs are visual representations of interrelated complex systems that are often used to facilitate systems thinking. Within the context of food systems, various studies have used causal loops to derive managerial and policy implications aiming to improve sustainability. Stave and Kopainsky (2015), for instance, focus on disturbances in national food systems by identifying relevant relationships and potential vulnerabilities. The authors show that food systems are not only at risk from external disturbances but are further challenged due to the internal

structure of modern food systems. The impact of the US food industry on energy usage is investigated by Xu and Szmerekovsky (2017). Through the identification of feedbacks and causal loops, the authors demonstrate that major savings in energy consumption are possible by increasing productivity and reducing waste. Amiri et al. (2020) employ CLDs to study the sustainability of Iranian wheat production. By analyzing different rainfall, technology, and soil quality scenarios, the authors highlight that tailored investments and planning approaches are required to secure sustainable food systems. In the context of alternative food networks, Melkonyan et al. (2020) compare various last-mile distribution strategies with the help of CLDs. The authors note that more collaboration between food producers and logistics service providers is required. Particularly, crowd logistics concepts show promising results to lower emissions and total costs of related systems.

Nevertheless, earlier work in the context of food systems that employed systems thinking predominately aimed to study quantitative relationships. In contrast, the present study aims to provide a holistic, systemic perspective on the challenges underlying the maintenance and diffusion of grassroots innovations in the food industry. Therefore, it uses CLDs as a *qualitative* method. As powerful visual tools, CLDs facilitate a profound understanding of the cause-and-effect relationships and feedback loops of the underlying system (Lane, 2008; Morecroft, 2015). By visualizing such cause-and-effect relationships, the inherent systemic challenges of alternative food networks can be studied in detail.

Fig. 1 provides a simplified example of a CLD based on Kim (1992) that visualizes dynamics of demand and supply. At its center stands the demand for a single product. If demand increases, shipping volumes rise too, which are constrained by a limiting factor such as available inventory levels. These facts are indicated by a plus and minus sign on the respective arrows. Higher shipping volumes further negatively impact service quality due to increased complexity, resulting in a decrease in demand. This balancing loop in the system is highlighted by a 'B' in the CLD. Additionally, a reinforcing loop, indicated by an 'R', can be identified. High demand leads to positive word-of-mouth, which increases future demand. As this effect, however, is not immediate, a delay, indicated by two vertical lines ||, is modeled.

We develop our CLDs for the case of a member-driven *food cooperative*, a self-organized network of producers (e.g., farmers) and buyers, who build and maintain structures to enable the regular purchase of food. Related notions are food teams (Crivits and Paredis, 2013), food-buying groups (Little et al., 2010), and collective purchase networks (Pellicer-Sifres et al., 2017). We chose food cooperatives as units of analysis for several reasons. First, they have been described as a common type an alternative food network and a typical form of grassroots innovations in the current food regime (Kirwan et al., 2013; Laforge et al., 2017, Little et al., 2010; Pellicer-Sifres et al., 2017). Moreover, they are often part of 'urban agriculture' initiatives (Gernert et al., 2018), thereby linking urban and regional areas. Such local, urban-regional food systems are seen as crucial building blocks for sustainability transitions in the food industry (Marsden and Sonnino, 2012).

The most important characteristic of a food cooperative, as in other grassroots innovations, is its self-organizing nature (Little et al., 2010). Although there are many variants of alternative food networks (Clark and Inwood, 2016), in essence, they comprise three key roles, *farmers* (production), *retailers* (distribution), and *consumers* (consumption; Brinkley, 2018). In a food cooperative, there is no dedicated retailer, but this role is shared by consumers and farmers. Consumers usually organize the selection of farmers, the ordering process, the storage and distribution amongst participants as well as the payment (Crivits and Paredis, 2013); farmers are typically responsible for the packaging as well as the timely and safe transport of products (Jaklin et al., 2015).

3.2. Modeling procedure of CLDs

Our work aims to synthesize the *existing empirical research* on factors related to the formation and maintenance of a food cooperative and its diffusion to a larger scale into coherent systemic CLD models. Hence, the core of our method is a review of the existing literature. However, a classic systematic literature review with a linear procedure of 'querying', 'reduction of the literature' and 'synthesis' (e.g., Tranfield et al., 2003) is not ideal for developing CLDs because not all relevant variables—and thus not all relevant search terms—are known in advance. Instead, a multi-staged, iterative modeling procedure is required.

Concretely, to develop our CLDs, we began by systematically searching the key databases (ProQuest, ABI Informs) as well as Google Scholar for empirical research on food cooperatives, using also the above-mentioned synonyms (food teams, food buying groups, etc.) as search terms. Moreover, we analyzed the review articles by Gernert et al. (2018) and El Bilali (2019a, b) for relevant empirical findings and further potentially related work. Starting from this initial set of articles, we developed a list of empirically identified relations between variables (e.g., *high cost* reduces *consumer experience*; *logistics efforts* increase *cost*). We then merged similar variables and sorted them into higher-order categories (e.g., consumers' motives, dimensions of consumer experience) to identify the relevant areas of our CLDs.

Based on this list of variables and their interrelations, and considering system archetypes as described by Kim (1992), we constructed initial CLDs to visualize typical cause-effect relationships and relevant feedback loops in food cooperatives. Once all these categories and archetypes were considered in the initial CLDs, additional literature searches were performed to validate the identified relationships. If new factors or conflicting references were found, the CLDs were adapted accordingly. This procedure was repeated multiple times until we reached a state of saturation (Saunders et al., 2018) in the sense that no

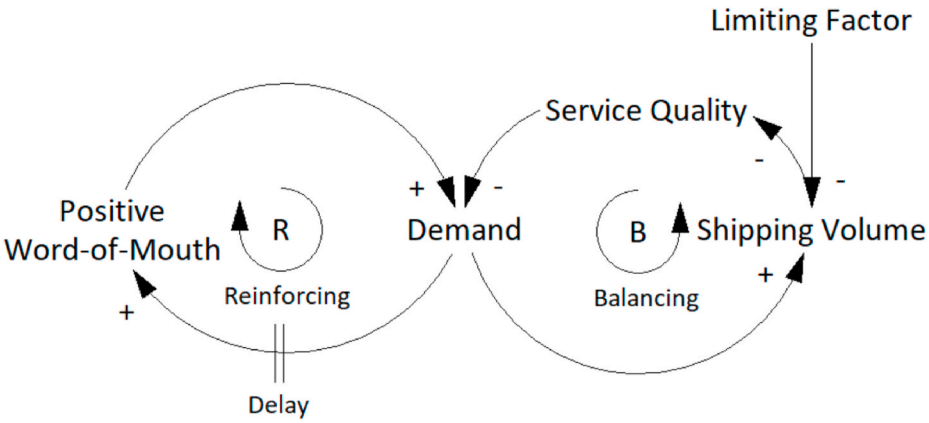

Fig. 1. A CLD with a reinforcing (R) and balancing (B) loop based on Kim (1992).

further relevant variables were identified. Finally, we applied a procedure of construct validation: We checked each link against the backdrop of the literature to make further corrections, if necessary. Through this iterative modeling process, it was ensured that all variables and arcs in our resulting CLDs are backed by empirical evidence.

4. Causal loop diagrams (CLDs) of alternative food networks

The following sub-sections present the CLDs that resulted from the iterative literature-based modeling approach as described in Section 3.2. The CLDs display the inherent systemic characteristics and challenges of food cooperatives as typical grassroots innovations in the food industry. To facilitate readability and understanding, the CLDs in this work are presented sequentially along with the two aspects of the research question. Therefore, in a first step, we set the focus on the systemic mechanisms underlying the establishment and maintenance of a food cooperative. In a second step, we discuss variables and feedback loops related to the scaling of such grassroots innovations, thereby considering the role of and impact on the involved farmers. All CLDs were drawn with Vensim PLE 8.2 (Vensim, 2021).

4.1. Formation and maintenance of a food cooperative

The first CLD (Fig. 2) displays factors that lead to the formation of a food cooperative. Most importantly, it shows participants' typical motives to fund or participate in such an initiative (Table 1) and their requirements on the overall 'consumer experience' (Table 2).

Consumers' key motives to participate in a food cooperative are unmet needs, ideological reasons, and a desire for community (Table 1). As Fig. 2 shows, these factors affect the level of *user involvement*, which we define as consumers' willingness to participate in a food cooperative and take over responsibility. The overall *consumer experience* (i.e., level of satisfaction with the outcome) depends on the price and quality of goods, the offered service quality, and the level of personalization (Table 2). By personalization, we refer to the level of personal exchange and individualized consideration within a food cooperative.

The success of a food cooperative as a grassroots initiative depends on the recruitment of volunteers and their retention (Hibbert et al., 2003). As displayed in Fig. 2, there is a positive reinforcement loop between *consumer experience* and *number of food cooperative users*: If participants' consumer experience is positive, positive word-of-mouth may increase the involvement of active users and attract additional ones, thereby leading to growth (Hibbert et al., 2003). This initial growth has a positive effect on various dimensions of participants' consumer experience (Table 3). As indicated by the three reinforcing loops (R1-R3), increasing demand positively impacts prices as well as—through the inclusion of further farmers—the variety and quality of products (R1 and R2). Moreover, due to a higher delivery frequency (i.e., routinization), it increases service quality (R3).

However, as also shown in Fig. 2, there are inherent problems with maintaining a food cooperative of a certain size. First, growth often requires standardization of processes, (semi-)formalized organizational roles, and 'legal documents' (e.g., contracts of membership), all of which reduces personalization (B1). Then, participants' high expectations for

Table 1
Consumers' motives to participate in a food cooperative.

Consumers' Motives for Building and Maintaining a Food Cooperative	Reference(s)
Unmet needs	
Access to affordable, fresh, organic, local products	Little et al. (2010)
Access to new, unknown products (e.g., 'old' sorts of vegetables) that are unavailable in the supermarket	Crivits and Paredis (2013)
Farmers motives: Alternative forms of distribution, additional outlets	Little et al. (2010)
Ideological reasons of consumers	
Food sovereignty	Connelly and Beckie (2016); Little et al. (2010)
Moral/ethical reasons, response to perceived deficiencies in the conventional system; an ethic of 'good food'	Little et al. (2010)
Take back control over the own food supply	Little et al. (2010)
Active initiators: Enablers in the distribution of local and organic foods	Little et al. (2010)
Show alternative to/trigger change in the mainstream food regime	Connelly and Beckie (2016); Little et al. (2010)
Social ethic of creating positive communitarian capitals (perceived failure of conventional food regimes); collective action	Connelly and Beckie (2016); Little et al. (2010)
Consumers as active, innovative agents for change; 'food citizens'	Little et al. (2010)
Desire for community	Little et al. (2010)
Enhancing social networks; strengthening local communities	Crivits and Paredis (2013); Hibbert et al. (2003); Little et al. (2010)
"Shopping together" as a collective experience	Little et al. (2010)
Solidarity with regional farmers; advancement of rural sustainability; general possibility to communicate with farmers	Crivits and Paredis (2013); Little et al. (2010)

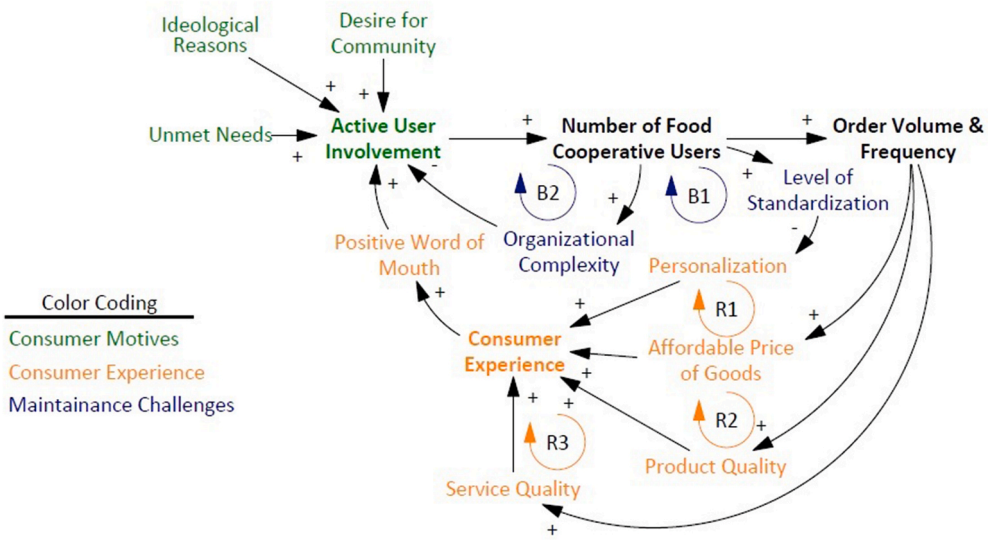

Fig. 2. Initial growth phase of food cooperatives.

Table 2
Dimensions of consumer experience.

Dimensions of Consumer Experience in a Food Cooperative	Reference(s)
Price of goods (affordable)	
Affordable for consumers	Little et al. (2010)
Profitable for producers	van den Heiligenberg et al. (2017)
Products of high quality (local, fresh, high variety)	Crivits and Paredis (2013)
Service Quality	
Purchase is perceived as convenient (within the 'normal' constraints inherent to a food cooperative)	Crivits and Paredis (2013)
Flexibility in purchase	Little et al. (2010)
Reliability of delivery	Crivits and Paredis (2013)
Personalization	
Personal interaction, general level of trust, tolerance, and accountability between actors	Connelly and Beckie (2016); Crivits and Paredis (2013); van den Heiligenberg et al. (2017)

Table 3
Effects of growth on different dimensions of consumer experience.

Causal Relationships regarding Effects of Growth in a Food Cooperative	Reference(s)
Effects of growth on price	
Larger number of users reduces overhead (e.g., infrastructure, logistics)	Connelly and Beckie (2016); van den Heiligenberg et al. (2017)
Regular orders are required (i.e. consumers' commitment to order) to reduce producers' costs	Crivits and Paredis (2013); Jaklin et al. (2015)
Larger number of users requires coordinators who may need to be compensated (e.g., monetary, food credits)	Little et al. (2010)
Increased demand requires larger material infrastructure (e.g., depot, fridge, other artifacts), which may increase costs	Crivits and Paredis (2013); Little et al. (2010); van den Heiligenberg et al. (2017)
Effects of growth on products/product quality	
Steady demand for products increases planning reliability for producers (negative effect on producers' costs)	Connelly and Beckie (2016);
Growing demand within food cooperative may exceed (regional) small farmers' production capacities	Little et al. (2010)
Effects of growth on personalization	
Larger number of users requires 'standardization' of processes (e.g., inclusion of new farmers or consumers, taking orders, distribution of products, payment) and reduces flexibility and individualization	Crivits and Paredis (2013); Little et al. (2010)
Larger number of users requires organizational roles (e.g., depot coordinators, product managers) and reduces individual contacts and personal interactions	Crivits and Paredis (2013)
Larger number of users requires more 'legal' documents than just verbal agreements (e.g., membership, decision-making)	Connelly and Beckie (2016); Little et al. (2010)
Larger number of users results in difficulties in acquiring and integrating new members	Tavella and Papadopoulos (2017)
Effects of growth on service quality	
Larger orders require more suppliers or larger suppliers	Clark and Inwood (2016)
Increased scale and distribution channels become more streamlined and formalized	Clark and Inwood (2016); Connelly and Beckie (2016);
Larger and regular orders as well as logistics collaboration results in a substantial reduction in last-mile delivery costs	Fikar and Leithner (in press)
Scaling-up enables food cooperatives to influence production standards and delivery conditions	Jaklin et al. (2015)
Lacking communication, transparency, and feedback within large food cooperatives leads to higher complexity and uncertainty of processes, as well as 'passive members' who do not take responsibility	Tavella and Papadopoulos (2017)

personalization, which are typical for food cooperatives (Connelly and Beckie, 2016; Crivits and Paredis, 2013; van den Heiligenberg et al., 2017), may not be met anymore. This does not only hold for interactions amongst consumers, but also for interactions with farmers who are limited regarding how much contact and individualization is possible with food cooperatives.

Concerning the second balancing loop (B2), due to increased organizational complexity, food cooperatives get less effective as the number of users increases (B2). Common challenges of large food cooperatives include miscommunication, lack of transparency, and misaligned goals of its participants; these factors reduce cohesion within the food cooperative and lead to 'passive members' (Tavella and Papadopoulos, 2017) who show little involvement and responsibility. Hence, increased complexity reduces active user involvement.

4.2. Scaling of a food cooperative

So far, we have dealt with factors related to the maintenance of a food cooperative. Now, we turn to issues of scaling and potential limits to growth. As the first limitation to growth, as shown in Fig. 3, the number of potential members is limited by the population of the area (B3). As the number of members increases, fewer potential new members exist, restricting growth of the cooperative. A second inherent limit to growth of a regional food cooperative are the limited production capacities of regional farmers (B4); that is, the growing demand of participants may at some point exceed the regional supply, constraining both order volume and frequency.

In the literature on alternative food networks, mainly the organizational challenges (e.g., standardization requirements; B1, B2) on the side of the consumers have been considered. The farmers' perspective has received much less attention so far. This neglect is serious because, in food cooperatives, consumers and farmers often do not share clear common goals (Jaklin et al., 2015). In this context, besides the two afore-mentioned inherent limits to growth, the operational and logistics capabilities of the involved farmers gain importance as the order volume of food cooperatives increases. The farmers' logistics performance is considered in Fig. 4 and linked to the other variables through the service quality variable.

By a farmer's logistics performance, we refer to the degree to which the farmer meets the food cooperative's logistics requirements (e.g.,

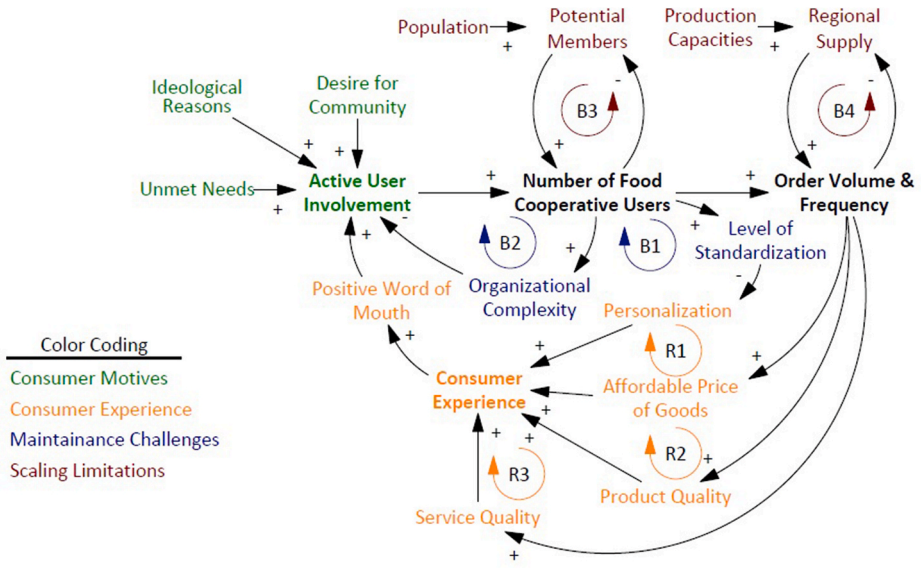

Fig. 3. Organizational factors limiting the growth of a food cooperative.

frequency, flexibility, reliability of deliveries). Farmers participating in food cooperatives are facing numerous inefficiencies, mostly due to infrequent or sudden orders, small quantities, and requirements on product standardization (Jaklin et al., 2015; Fikar and Leithner, in press). Moreover, low active user involvement can produce further inefficiencies, for example, through delayed orders (Tavella and Papadopoulos, 2017).

As Fig. 4 shows, to improve logistics performance, farmers have two main options, either strengthening cooperation to lower inefficiencies (B5) or investing in expanding the logistics capacities (B6). Cooperation can either be achieved through closer interaction with the food cooperative (vertical cooperation) or through shared logistics activities with other regional farmers (horizontal cooperation). For instance, if the farmer works closely together with the food cooperative, delivery times that fit the needs of both actors best can be identified to save costs (Jaklin et al., 2015). Between multiple farmers, joint deliveries can be organized to reduce travel distances and lower the number of required vehicles (Fikar and Leithner, in press).

Both options lead to an improvement in logistics performance; however, in both cases, it takes time until the interventions take effect. Once revealed in the logistics performance, service quality increases. This leads to positive word-of-mouth and higher future demand, again resulting in additional logistics requirements and the need for future interventions.

In terms of systems thinking, this instance shares similarities with the 'growth and underinvestment archetype' (Kim, 1992), where a reinforcing loop leading to the growth of a performance indicator is opposed by multiple balancing loops linking performance to capacity investments. This analysis suggests that there may be an 'optimal size' regarding order volume and frequency. As food cooperatives are highly dynamic initiatives with varying user numbers and level of involvement, however, this optimal size may fluctuate substantially over time.

Fig. 5 integrates all these key characteristics and gives a complete overview of reinforcing and balancing loops related to the formation, maintenance, and diffusion of alternative food networks as prototypical grassroots initiatives in the food industry.

5. Discussion

Earlier research has highlighted the potential of grassroots innovations for sustainability transitions in general (Hossain, 2016; Seyfang and Smith, 2007) and the food industry in particular (Ingram et al., 2015). While there is awareness in the literature that there are challenges related to (1) the formation and maintenance as well as (2) the diffusion of grassroots innovations to mainstream (Seyfang and Smith, 2007; Seyfang and Longhurst, 2016), the underlying systemic mechanisms remained underspecified. The aim of this article was to provide a systems thinking perspective on both these challenges in the context of alternative food networks. The resulting CLDs contribute to a better understanding of the potential and limitations of grassroots innovations as drivers of sustainability transitions in the food industry.

5.1. Formation and maintenance

The CLDs developed in this paper display the inherent systemic challenges related to the formation and maintenance of a food cooperative as a typical grassroots initiative in a structured manner. These problems are mainly related to the sensitive balance between users' motives to participate in a grassroots initiative (Table 1) and their expectations of the overall user experience (Table 2). As shown in Fig. 2, an increasing number of participants will first *improve* certain important dimensions of consumer experience (R1-R3). In the case of a food cooperative, as we have argued, increasing order volume and frequency may have positive effects on price, product quality, and service quality. However, a larger number of participants requires standardization and reduces personalization, both amongst consumers as well as between consumers and producers (i.e., farmers), thereby decreasing consumer experience (B1). Moreover, an increased number of participants leads to higher organizational complexity, which, is negatively related to participants' active involvement in the food cooperative (B2).

Additionally, while previous research on food cooperatives as alternative food networks has mainly considered organizational problems on the side of consumers (for an exception, see Connelly and

Beckie, 2016), the CLDs further include the farmers' logistics capabilities, which is one of the main limiting factor of service quality (Fig. 4). To facilitate successful operations, cooperation is often listed as a key success factor within a regional food supply chain (Paciarotti and Torregiani, 2021). Vertical cooperation between farmers and consumers enables better planning to reduce frequent inefficiencies in related delivery operations such as tight time windows and low shipping volumes. Horizontal cooperation, either between multiple farmers or multiple food cooperatives, can lead to a substantial reduction in logistics costs through resource pooling and more efficient vehicle routing (Connelly and Beckie, 2016; Fikar and Leithner, in press). In all these forms of logistics cooperation, the focus of the involved actors needs to be set on building trust to achieve high savings and enable robust business relationships (Serrano-Hernandez et al., 2018).

From a food systems perspective, many of these inherent problems may be attributed to the fact that in a food cooperative as a grassroots initiative, the important tasks of a retailer (i.e., all activities related to organizing the transfer from farmers to customers; Brinkley, 2018) are usually not formalized and compensated, but rely on voluntary work and active user involvement. While at a small scale, these tasks (e.g., selling food together) may contribute to feelings of community (Hibbert et al., 2003), at a larger scale this sense of community becomes diminished; the result can be 'passive members' who show little involvement, thereby reducing the overall consumer experience (Tavella and Papadopoulos, 2017). Because personal contact and interpersonal trust are amongst the key drivers and success factors of food cooperatives (Connelly and Beckie, 2016; Crivits and Paredis, 2013; Hibbert et al., 2003; Little et al., 2010), they seem to function best at a size where members manage to maintain regular personal interaction and a perception of a 'collective' (Tavella and Papadopoulos, 2017).

5.2. Diffusion to the mainstream

The afore-mentioned challenges of maintaining alternative food networks are directly related to challenges of diffusion. In general, when sustained over time, grassroots innovations can diffuse along three routes: *scaling-up* (i.e., growing in scale), *replication* at new locations, or *translation* into mainstream contexts (Seyfang and Longhurst, 2016). The presented CLDs enable us to be more precise on possibilities of and limits to diffusion of grassroots innovations along these routes.

Regarding the potential for *scaling-up* a food cooperative, earlier research has identified a 'paradox of diffusion' as a general problem of grassroots innovations, which provide solutions that are highly functional at small scales but become inferior at larger scales (Seyfang and Smith, 2007). Similarly, in the context of food systems, earlier theoretical (Sonnino and Marsden, 2006; Gaitán-Cremaschi et al., 2019; Therond et al., 2017) and empirical (Clark and Inwood, 2016; Pellicer-Sifres et al., 2017) research has suggested that some of the benefits of alternative food networks (e.g., coordination based on trust) become drawbacks when food systems grow. The CLDs in this paper portray some of the root causes of these scaling problems. Most importantly, the CLDs have made it clear that at a certain point, organizational challenges (e.g., complexity, inefficiencies) may exceed the possibilities of self-organization, both at the end of consumers (Fig. 3) and farmers (Fig. 4). The function of a retailer may have to be established to ensure a satisfactory overall user experience. Then, however, the grassroots character may vanish and the food cooperative may transcend into a different type of alternative food network (e.g., a local store). Moreover, beyond the organizational (i.e., complexity, standardization) and logistic issues (i.e., inefficiencies, limited capacities) outlined above, there are some additional 'hard facts' that limit the potential for scaling-up (Fig. 3): One is the potential number of consumers; the other, more important factor is the limited regional production capacities. In summary, increasing its scale to deliver food to a large, anonymous group of customers is not a feasible option for a self-organized food cooperative.

Instead, food cooperatives as grassroots innovations may be diffused in the food system through the route of *replication*; other actors may build similar structures at different locations and in different regions. As related studies in agriculture (Millar and Connell, 2010; Wigboldus et al., 2016) and other contexts like the diffusion of community currencies (Seyfang and Longhurst, 2016) or education projects (Jowett and Dyer, 2012) have shown, such replication may follow different trajectories and take different shapes. To disseminate their ideas, participants of food cooperatives who aim to change conventional food regimes may share their experiences and artifacts (e.g., contracts, ordering software) with groups at other locations to increase the likelihood of success in other regions. Although the single food cooperatives may remain rather small in scale, a large number of food cooperatives at many different locations, especially in urban areas, can be a 'significant counterforce to the global intensive food agenda' (Marsden and Sonnino, 2012, p. 428).

Finally, even if grassroots innovations are not immediately scaled-up or replicated, they serve as a proof-of-concept that alternative practices are possible (Seyfang and Smith, 2007) and parts of the initiative may be diffused to the mainstream through *translation* (Seyfang and Longhurst, 2016). Translation means that mainstream actors adopt some of the ideas and approaches from the grassroots innovation. Ingram et al. (2015) discussed potential niche-regime interactions in the food industry, which may range from *compatible* or *complementary* where conventional food systems include some innovative features to *divergent* or *oppositional*, where the compatibility between the niche and the regime is low and niche actors may even oppose the regime. In general, grassroots initiatives usually seek to stretch-and-transform the existing

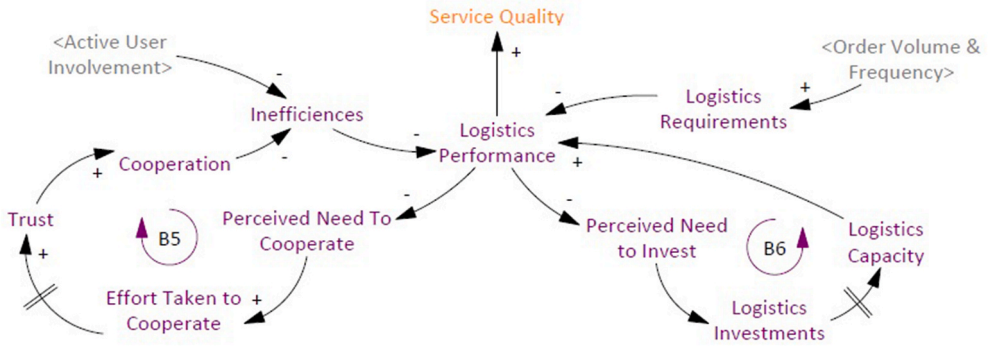

Fig. 4. Farmer interventions to improve logistics performance in a growing food cooperative.[1].

[1] The grey text in angle brackets represents shadow variables, i.e., links to factors included in Fig. 3.

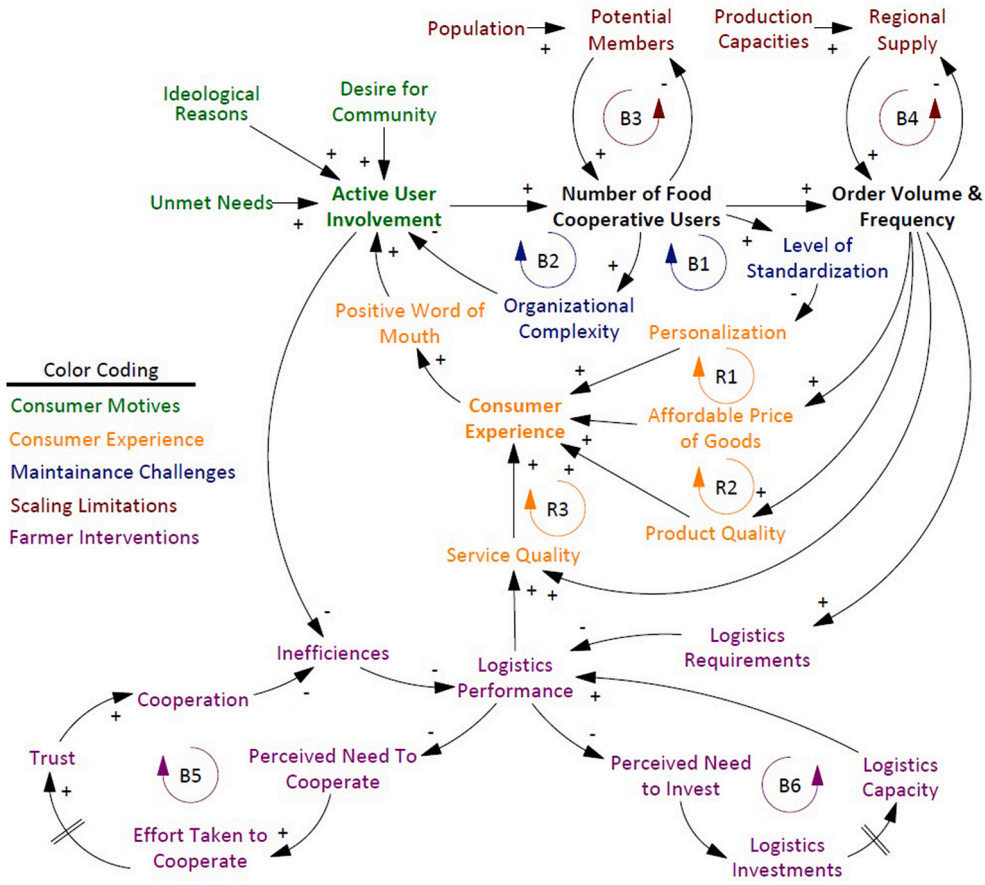

Fig. 5. CLD investigating the maintenance and diffusion of food cooperatives.

regime, rather than fit-and-conform with it (Smith and Seyfang, 2013; see also Seyfang and Smith, 2007); hence, they often belong to the divergent or oppositional categories. Nevertheless, the "act of creating alternative distribution mechanisms that respond to perceived deficiencies within the current system is an intervention", which can serve as an implicit critique of the regime (Little et al., 2010, p. 1084) and change consumers' awareness of and attitude toward food and the conventional food industry. Then, mainstream actors such as supermarkets may adopt some of the ideas (e.g., by dedicating special store space with attractive shelving for local farm products) and diffusion takes place through *translation*.

5.3. Policy implications

Urban-regional food systems are important building blocks for sustainability transitions (Marsden and Sonnino, 2012); hence, policy-makers may be interested in supporting the maintenance and diffusion of food cooperatives and other alternative food networks. Our findings reveal several policy implications on how to facilitate such initiatives.

In general, our findings suggest that policy-makers should incentivize replication of several smaller-scale alternative food networks in multiple regions, rather than scaling-up existing initiatives. This may contribute to reconnecting cities with the countryside—a strategy that has been suggested as a potential solution to many food-related crises (Marsden and Sonnino, 2012). As a most striking example, the COVID-19 pandemic has demonstrated the relevance of short food supply chains and local productions for preserved access to high-quality food (Capelli and Cini, 2020). Moreover, regarding the maintenance of alternative food-networks, initiatives may be dedicated to encouraging cooperation and knowledge sharing, both horizontally amongst members of different alternative food networks and vertically between farmers and food cooperatives (Beckie et al., 2012; Connelly and Beckie, 2016).

Furthermore, education and information campaigns may be initiated to increase the general awareness and understanding of food supply chains as well as the related risks and problems. Increased knowledge of agricultural and sustainability issues may encourage a growing number of people to participate in alternative food systems (Chiffoleau et al., 2016; Kirwan et al., 2013), thereby gradually transferring grassroots innovations from niches to the mainstream (Geels and Schot, 2007).

Finally, alternative food networks should not be seen as separate spheres from the existing regime (Sonnino and Marsden, 2006); instead, in the course of sustainability transitions, many hybrid forms may exist where conventional and alternative food systems are complementary, or where conventional food systems include some innovative features of alternative ones (Gaitán-Cremaschi et al., 2019; Lamine et al., 2019). Hence, policy-interventions may be designed to encourage players in the conventional food regime (e.g., supermarkets) to cooperate with local alternative food networks (Chiffoleau et al., 2016), for example, by developing labels that indicate 'fair trade' with or 'regional selling' from local producers.

6. Conclusions

In this paper, we answered earlier calls for systemic perspectives to better understand the inherent challenges of (1) maintaining and (2) diffusing grassroots innovations in the food industry. Therefore, we reviewed the existing literature on food cooperatives and employed CLDs to model the underlying systemic dynamics and feedback loops. Concerning (1) challenges related to the formation and maintenance of alternative food networks, we came to the conclusion that food

cooperatives seem to have an 'optimal size': A certain amount of participants—both farmers and consumers—is necessary to meet users' expectations (e.g., supply, affordability); at the same time, when such systems become too large, there are negative feedback loops on users' motivational factors. In particular, a lack of personalization due to standardization and a lack of personal interaction can decrease the overall user experience. Regarding (2), the scaling of grassroots innovations in the context of alternative food networks, it is exactly these identified feedback loops that explain the 'paradox of diffusion' (Seyfang and Smith, 2007) that has been mentioned in other contexts: The CLDs suggest that the 'paradox of diffusion' in food cooperatives is strongly related to limits to *personalization*. Because a feeling of community is one of the core motives to participate (Crivits and Paredis, 2013; Hibbert et al., 2003; Little et al., 2010), food cooperatives come to their limits when they become too formalized, commercial and lose their 'community character'. Together with constraints to regional supply, this limits the possibility to diffuse grassroots innovations via *scaling-up*. Food cooperatives, as prototypical grassroots innovations in the food industry, may only be diffused through *replication*. Consequently, we conclude that policy-makers should focus on incentives for the replication of food cooperatives at different locations and on measures that facilitate mutual learning and knowledge transfer.

Like any research, our work has several limitations that may be addressed in the future. As a first limitation, we build generic CLDs for food cooperatives that neglect area-specific geographical, cultural, and legal conditions. In future research, our findings may be instantiated for specific cultural and regional contexts. Additionally, a closer investigation of other types of alternative food networks, such as farmer markets and community-supported agriculture, would be of interest to validate our findings and facilitate grassroots innovations in other food-related contexts. As a second limitation, we chose a qualitative approach based on a review of the literature to identify general mechanisms and causal loops. Future empirical work may be dedicated to validate our CLDs and investigate variations in organizational characteristics of food cooperatives, for example, by applying a group model building approach (Cunico et al., 2021; Scott et al., 2016) with experts from different regions. On a related note, future empirical research may focus on the individual parameters (e.g., type of goods, characteristics of the region) for the optimal size of a food cooperative. In this context, quantitative approaches to systems thinking, such as simulation modeling, may be employed to investigate various real-world cases in more detail.

CRediT authorship contribution statement

Barbara Kump: Conceptualization, Methodology, Validation, Resources, Data curation, Writing – original draft, Writing – review & editing, Project administration. **Christian Fikar:** Methodology, Software, Validation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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